REMARKS

Claims 1–52 and 76–81 are pending in this application. Claims 1, 2, 16, 26, 30, and 31 were amended in the Amendment and Response filed December 19, 2006, to clarify the subject matter Applicants regard as their invention. Support for those claim amendments can be found in the specification, for example, at least on page 9, lines 24-29, on page 11, lines 25-28, and on page 13, lines 7-9, and as discussed in detail below. No new matter has been added.

Applicants note with appreciation that the Examiner has allowed claims 35, 45-52, 80 and 81.

In the Office action mailed on March 21, 2007, the Examiner entered but, in light of rejection under 35 U.S.C. § 112, first paragraph, apparently did not consider the claim amendments filed on December 19, 2006. We herein address the rejections under § 112 and discuss the substance of the amendments and their bearing on the cited art.

The current listing of claims lists the claims as entered subsequent to the filing of the Amendment and Response on December 19, 2006.

Claim Rejections under 35 U.S.C. § 112

Claims 1-34, 36-44, and 76-79 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. The Examiner states that the amendment to independent claims 1, 2, 16, 26, and 31, added in Applicants' Response filed December 19, 2006 ("the previous Response"), constitutes new matter and is not supported by the Specification.

Applicants respectfully submit that, as set forth in the previous Response, adequate support for the limitation at issue is present at least on page 9, lines 24-29, on page 11, lines 25-28, and on page 13, lines 7-9. Additional support may be found at least on page 12, line 5 to page 13, line 19; page 13, lines 26-27; page 16, line 12; and Figures 3, 5, 6, and related text.

As taught repeatedly in the Specification, embodiments of Applicants' invention include annealing a semiconductor layer to reduce an initial compositional variation throughout a

semiconductor layer by diffusing one or more elements throughout the semiconductor layer, as recited in independent claims 1, 2, 16, 26, and 31 (as amended in the Response filed December 19, 2006). The Specification teaches that annealing the semiconductor layer may promote this diffusion. *See* Specification, page 12, line 5 to page 13, line 19. Moreover, such annealing and concomitant diffusion may result in the elimination of compositional variations such as superlattice 24 and columns 50, 52, as well as in the semiconductor layer having a homogeneous (i.e., relatively uniform) composition. *See* Specification, page 11, lines 25-31, page 13, lines 26-27, and page 16, line 12. This effect is schematically depicted in a comparison of Figures 3 and 5, in which compositional variations within a layer are clearly evident, to Figure 6, in which such compositional variations are no longer present. Such homogeneity in the composition of the semiconductor layer results from the diffusion of at least one of the two elements throughout the semiconductor layer, as recited in independent claims 1, 2, 16, 26, and 31 (as amended in the Response filed December 19, 2006). If at least one of the two elements did not diffuse throughout the semiconductor layer, a homogeneous composition of the semiconductor layer could not be achieved.

Applicants submit that at least for these reasons, independent claims 1, 2, 16, 26, and 31 satisfy the written description requirement. In view of the foregoing discussion, Applicants further respectfully request that the Examiner withdraw the finality of the rejection and consider the claims in view of the following arguments.

Claim Rejections under 35 U.S.C. § 103

In the Office action mailed March 21, 2007, the Examiner repeats the rejections of the Office action mailed September 19, 2006; the following arguments were presented in the Responses mailed December 19, 2006, and May 21, 2007, and, in view of the rejections under § 112, appear not to have been considered. In view of the foregoing discussion, Applicants request the Examiner to consider the arguments presented below.

Schaake in view of Nakamura and Kao

Claims 1, 4–9, 23–25, 37, 38, and 76–79 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,960,728 to Schaake et al. ("Schaake") in view of U.S. Patent

Publication No. 2004/0060518 by Nakamura et al. ("Nakamura") and U.S. Patent No. 5,415,128 to Kao et al. ("Kao"). Schaake appears to disclose the formation of II-VI films by MBE or MOCVD, and the performance of a homogenization anneal to reduce compositional variations caused by surface faceting that occurs during the growth of the films. *See* column 1, lines 63–65, column 2, lines 15-18. Schaake does not teach or suggest rotating the substrate during the formation of the semiconductor layer, and, accordingly, cannot teach or suggest reducing compositional variations caused by such rotation.

The Examiner relies on Nakamura for the disclosure that rotating a substrate during layer formation by MOCVD can obtain a more uniform growth, and that some non-uniformity in the semiconductor layer can occur when implementing rotation (*see* sections 0007 and 0010). The Examiner relies on Kao for the disclosure that deposition by MBE can include substrate rotation and that compositional uniformity can occur during rotation under certain circumstances. (*see* column 1, lines 31-40). Neither Nakamura nor Kao, however, teaches or suggests annealing as a way to reduce an initial compositional variation caused by substrate rotation, as recited in the amended claims.

More specifically, neither Schaake nor Nakamura teaches or suggests a semiconductor layer with an initial compositional variation caused by the rotation of a substrate during formation of the semiconductor layer, which is reduced throughout the semiconductor layer by annealing and diffusing at least one of two elements throughout the semiconductor layer. Indeed, Applicants respectfully submit that one of ordinary skill in the art would have no motivation to incorporate into Schaake a rotation of the substrate in accordance with either Nakamura or Kao, particularly since these references teach that the result of such rotation could be to *cause* an initial compositional variation — the opposite of the result desired by Schaake.

Applicants submit that for at least these reasons, independent claim 1 is patentable over the cited prior art.

Bedell in view of Kao

Claims 1–3, 21, 22, and 42 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,841,457 to Bedell et al. ("Bedell") in view of Kao. Bedell discloses the formation of a Si_xGe_{1-x} layer over a single-crystal Si layer. *See* column 6, lines 35–46. A

subsequent anneal is performed to relax the strained SiGe alloy and to permit interdiffusion and redistribution of Ge between the first single-crystal Si layer and the Si_xGe_{1-x} layer. *See* column 8, lines 11–21. As the Examiner recognizes, Bedell does not teach or suggest rotating the substrate during the formation of the semiconductor layer; the Examiner relies on Kao to provide this feature.

Bedell appears to disclose the redistribution of Ge in two layers; Bedell does not teach or suggest reducing an initial compositional variation throughout a single layer by diffusing at least one of the elements *throughout that layer*, as recited in independent claims 1 and 2.

The Examiner asserts that Bedell discloses a relaxation anneal that "at very least reduces the initial compositional variation of the strained SiGe alloy" and that the diffusion of Ge is likely to decrease compositional variation, in particular, because one could refer to a portion of the semiconductor layer having the highest compositional variation with respect to Ge as "the initial compositional variation," and that after any of the annealing processes disclosed by the cited references, the diffusion of Ge would result in a reduction of Ge-compositional variation in that portion.

Applicants respectfully traverse this reasoning. The phrase "initial compositional variation" in the claims, read in light of the specification, clearly denotes the difference between the highest and lowest concentration of one of the elements within the layer. In particular, the specification illustrates the phrase as follows: "For example, if semiconductor layer 16 includes 20% Ge ($Si_{0.80}Ge_{0.20}$), the actual Ge concentration within layer 16 may vary by a total of 4%, e.g., 18-22%." *See* Specification, page 9, lines 24-29. Applicants have amended independent claims 1, 2, 16, 26, and 31 to further clarify that the initial compositional variation is reduced *throughout the semiconductor layer*.

Accordingly, the redistribution of Ge in two layers, as disclosed by Bedell, and the lowering of the concentration of the Ge in the original Si_xGe_{1-x} layer of Bedell does not necessarily reduce the initial compositional variation throughout the semiconductor layer, as recited in independent claims 1 and 2. In fact, the diffusion of Ge is likely to increase the initial compositional variation in the original Si_xGe_{1-x} layer such that the Ge concentration is lowest at the Si_xGe_{1-x}/Si interface, i.e., at the point where Ge atoms diffuse from the Si_xGe_{1-x} layer into the

Si layer and Si atoms diffuse from the Si layer into the Si_xGe_{1-x} layer, and highest at a distal portion of the Si_xGe_{1-x} layer. This is obviously inconsistent with the amended claim language.

Moreover, one of skill in the art would find no motivation in the cited references to rotate the substrate of Bedell as disclosed by Kao, since Kao teaches that such rotation can induce undesirable compositional variations.

Applicants submit that for at least these reasons, independent claims 1 and 2 are patentable over the cited prior art.

Yamane in view of Kao and Ohori

Claims 1 and 10–15 are rejected under 35 U.S.C. § 103(a) as anticipated by U.S. Patent No. 4,914,488 to Yamane et al. ("Yamane") in view of Kao. Claims 23, 32, 33 and 36-40, which depend either directly or indirectly from claim 1, are also rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamane in view of Kao and further in view of U.S. Patent No. 5,844,260 to Ohori ("Ohori").

Yamane describes a superlattice film having two kinds of layers with different compositions. *See* abstract. By subjecting the superlattice film to an annealing step, "the composition distribution can be smoothened. The superlattice structure can be transformed to a continuous structure of a graded composition." *See* column 7, lines 15–28. As the Examiner recognizes, Yamane does not teach or suggest rotating the substrate during the formation of the semiconductor layer. The Examiner relies on Kao to provide this feature.

The compositional variation in Yamane's superlattice appears to be formed by the deposition of superthin layers. *See* column 6, lines 56–63. One of skill in the art would not be motivated to cause an initial compositional variation by rotation of the substrate and annealing the film to reduce the variation, as recited in amended independent claim 1, because the starting material of Yamane already has a compositional variation — i.e., precisely alternating layers of different materials. There is no motivation to increase this initial variation further by rotating the substrate as described by Kao, in particular, since Kao teaches that such rotation can induce additional unwanted compositional variations.

Applicants submit that for at least this reason, independent claim 1 is patentable over the cited prior art.

layer, and is silent about changing the composition of the SiGe layer. As the Examiner recognizes, Malik does not teach or suggest rotating the substrate during the formation of the semiconductor layer. The Examiner relies on Kao to provide this feature. As the Examiner also recognizes, Malik does not teach or suggest annealing a semiconductor layer to reduce the initial compositional variation within a layer, as recited in independent claims 1 and 26. The Examiner asserts that the annealing process in Malik that is performed to relax the SiGe film will reduce the initial compositional variation in at least some portions of the SiGe film.

Again, and for the reasons discussed above, Applicants respectfully traverse the Examiner's interpretation of the phrase "initial compositional variation." Accordingly, lowering the concentration of the Ge in the original SiGe layer disclosed by Malik, or performing a relaxation anneal, does not necessarily reduce the initial compositional variation throughout the semiconductor layer, as recited in claims 1 and 26. Rather, the out-diffusion of Ge into neighboring Si is likely to increase the initial compositional variation in the original SiGe layer such that the Ge concentration is lowest at the SiGe/Si interface — i.e., at the point where Ge atoms diffuse from the SiGe layer into the Si layer and Si atoms diffuse from the Si layer into the original SiGe layer — and highest at a distal portion of the SiGe layer.

Applicants submit that for at least these reasons, independent claims 1 and 26 are patentable over the cited prior art.

Notsu in view of Nakamura

Claims 1, 23, 31, 32, 34, and 42–44 are rejected under 35 U.S.C. § 103 as unpatentable over U.S. Patent Publication No. 2002/0146892 by Notsu et al. ("Notsu") in view of Nakamura. Notsu appears to disclose forming a Si layer over a SiGe layer by CVD, diffusing Ge into the Si layer to form a SiGe layer, and annealing the layers such that the Ge concentration in the second SiGe layer becomes uniform. *See*, e.g., paragraphs [0101], [0102], and [0113]. As the Examiner recognizes, Notsu does not teach or suggest rotating the substrate during the formation of the semiconductor layer. The Examiner relies on Nakamura to provide this feature.

Notsu appears to disclose the redistribution of Ge in several layers, rather than within and throughout a layer, as recited in independent claims 1 and 31. Furthermore, as discussed, lowering the concentration of the Ge in the original SiGe layer disclosed by Notsu does not

Christiansen in view of Kao

Claims 16–20 and 41 are rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent No. 6,515,335 to Christiansen et al. ("Christiansen") in view of Kao. Christiansen appears to disclose the formation of Ge or SiGe islands on top of a Si layer by, e.g., MBE or CVD. A subsequent anneal causes intermixing between the islands and the Si layer. *See*, e.g., column 5, lines 18–30, column 6, lines 5–15 and 42–46. As the Examiner recognizes, Christiansen does not teach or suggest rotating the substrate during the formation of the semiconductor layer. The Examiner relies on Kao to provide this feature.

Like Bedell, Christiansen appears to disclose the redistribution of Ge in two layers. Christiansen does not teach or suggest reducing an initial compositional variation throughout a layer by diffusing at least one of the at least two elements throughout the layer, as recited in amended independent claim 16. Furthermore, lowering the concentration of the Ge in the original SiGe islands disclosed by Christiansen does not necessarily reduce the initial compositional variation, i.e., the difference between the highest and lowest concentrations within the layer, as recited in claims 1 and 16. On the contrary, as discussed above, the diffusion of Ge is likely to increase the initial compositional variation in the original SiGe islands such that the Ge concentration is lowest at the SiGe/Si interface (i.e., at the point where Ge atoms diffuse from the SiGe islands into the Si layer and Si atoms diffuse from the Si layer into the SiGe islands), and highest at a distal portion of the SiGe islands. Moreover, there is no motivation to rotate Christiansen substrate in accordance with Kao at least because Kao teaches that such rotation can exacerbate an initial compositional variation.

Applicants submit that for at least these reasons, independent claim 16 is patentable over the cited prior art.

Malik in view of Kao

Claims 1, 23, and 26–30 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2004/006744 by Malik et al. ("Malik") in view of Kao. Malik discloses forming a strained SiGe layer by MBE or CVD, and then relaxing it by an annealing step. *See* paragraphs [0013]– [0016]. Malik discusses only changing the stress level of the SiGe

necessarily reduce the initial compositional variation throughout the semiconductor layer, as recited in claims 1 and 31. Moreover, there is no motivation to rotate the substrate of Notsu in accordance with Kao at least because Kao teaches that such rotation can cause an initial compositional variation.

Applicants submit that for at least these reasons, independent claims 1 and 31 are patentable over the cited prior art.

CONCLUSION

In light of the foregoing, Applicants respectfully submit that all claims are now in condition for allowance.

A petition for a one-month extension of time is included herein. The Commissioner is hereby authorized to charge the required fee of $120 to Deposit Account No. 07-1700. Applicants believe that no additional fees are necessitated by the present Response. However, in the event that any additional fees are due, the Commissioner is hereby authorized to charge any such fees to Deposit Account No. 07-1700.

If the Examiner believes that a telephone conversation with Applicants' agent would expedite allowance of this application, the Examiner is cordially invited to call the undersigned.

Respectfully submitted,

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